N80-19170

FY 79 - DEVELOPMENT OF FIBER OPTICS
CONNECTOR TECHNOLOGY FOR LARGE SPACE SYSTEMS

Thomas G. Campbell
Langley Research Center
November 8, 1979

DEVELOPMENT OF FIBER OPTICS TECHNOLOGY FOR LARGE SPACE STRUCTURES

OBJECTIVE:

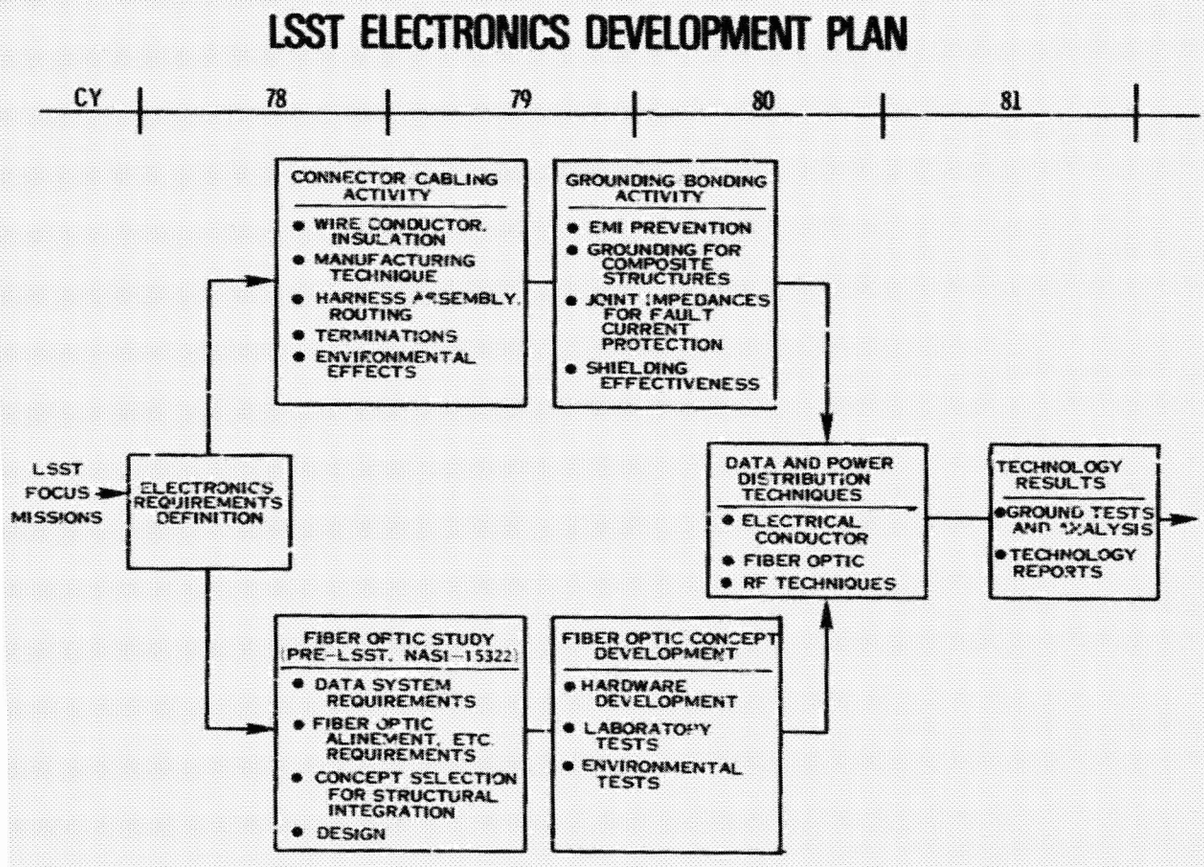
TO DEVELOP PHYSICAL CONCEPTS FOR INTEGRATING FIBER OPTIC CONNECTORS AND CABLES WITH STRUCTURAL CONCEPTS PROPOSED FOR LSST. EMPHASIS IS PLACED ON REMOTE CONNECTIONS USING INTEGRATED CABLES.

The inherent advantages in using a fiber optics communications system are listed below

F/O COMMUNICATION SYSTEM QUALITIES

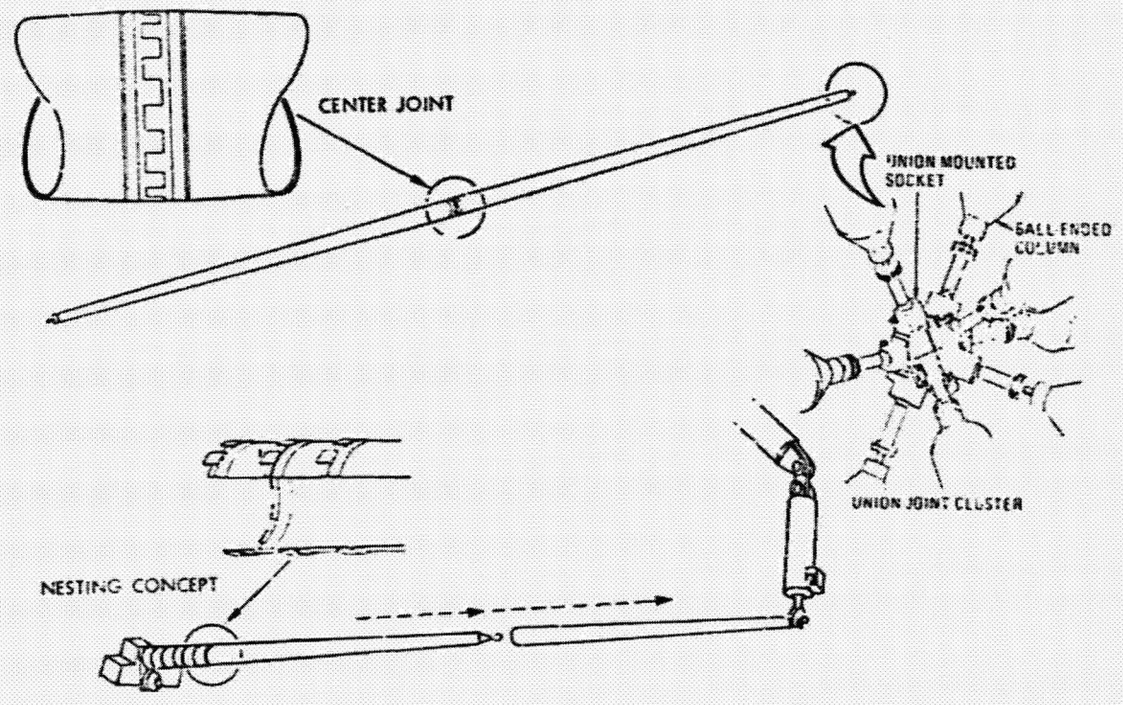
- HIGH DATA RATES
- NO CROSS TALK
- NO EMI
- SECURE COMMUNICATIONS
- LIGHT WEIGHT

The LSST Electronics development plan is shown below. This plan separates the fiber optic activity from the basic connector/cabling activity that is under the management of the Marshall Space Flight Center.



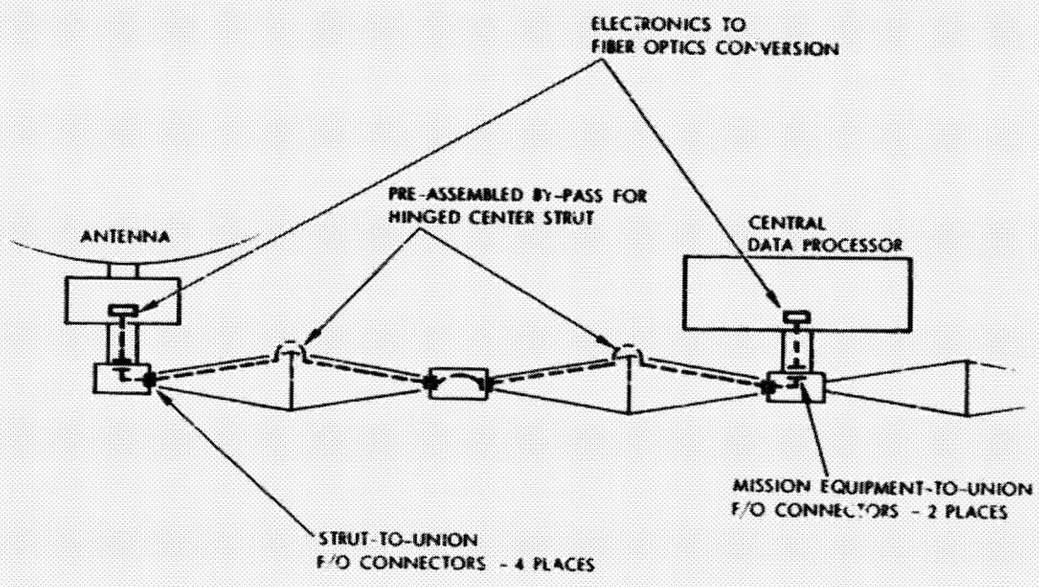
The fiber optics development effort for large space structures was initiated with a specific structured element in mind, specifically, the nestable column as shown below. The F/O connector is being developed to be compatible with the union joint cluster and the assembly concept using the End-Effector of the Shuttle RMS.

NESTABLE COLUMN



This figure shows the basic concept of integrating the F/O connector into the large space structure.

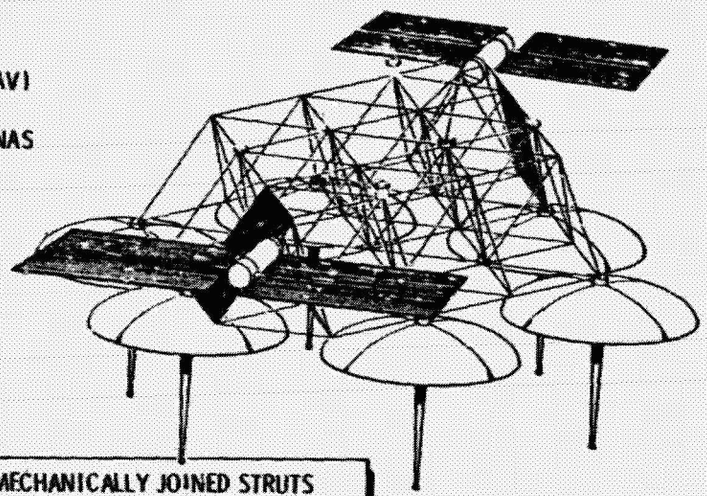
ANTENNA TO CENTRAL PROCESSOR CABLE PATH



The Electronic Mail Satellite (EMS) concept shown below was used to define the requirements for the fiber optics development effort.

TASK 1 MODEL SYSTEM
ELECTRONIC MAIL SATELLITE

550 POSTAL CENTERS
48 M PAGES MAIL/24 HRS (AV)
5 OPERATING AREAS
5 ACTIVE IN-ORBIT ANTENNAS
+1 SPARE
110 CHANNELS/ANTENNAE



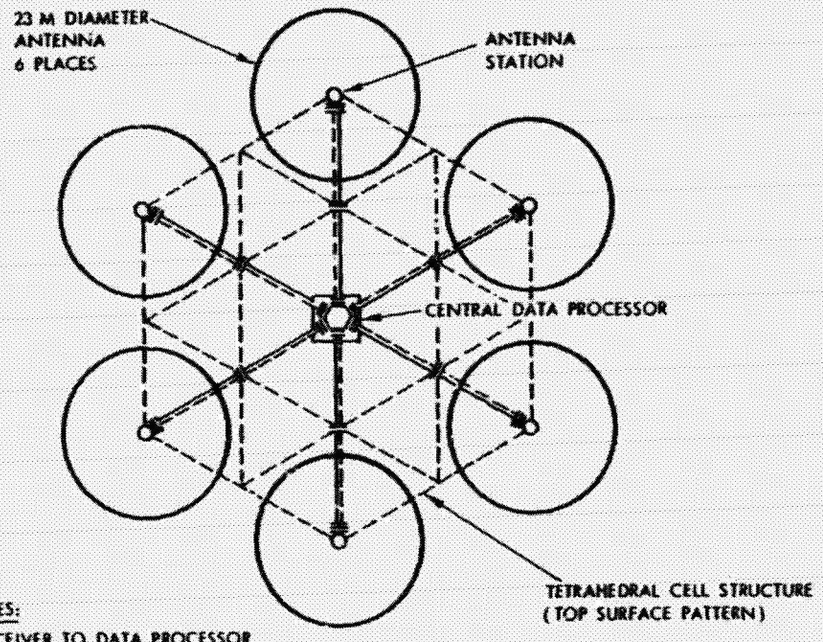
STRUCTURE: MECHANICALLY JOINED STRUTS
129 STRUTS, EA 15M LONG
33 UNIONS, EA 17 CM DIA

DIMENSIONS: LENGTH 96M
WIDTH 61M
HEIGHT 12M

WEIGHT: 37,280 LB (DRY)

A schematic wiring diagram for the conceptual EMS system is shown below.

SCHEMATIC WIRING DIAGRAM, COMMUNICATIONS, FOR EMS MODEL



FIBER OPTICS CABLES:

——— RECEIVER TO DATA PROCESSOR

– – – DATA PROCESSOR TO TRANSMITTER

—‖— FIBER OPTICS CONNECTORS AND INPUT/OUTPUT DEVICES

The requirements proposed for the Electronic Mail Satellite mission scenario are presented below. Also presented is a comparison of various cable systems and the weight reduction that a typical F/O system would have over conventional systems.

REQUIREMENTS PROPOSED FOR ELECTRONIC MAIL SATELLITE

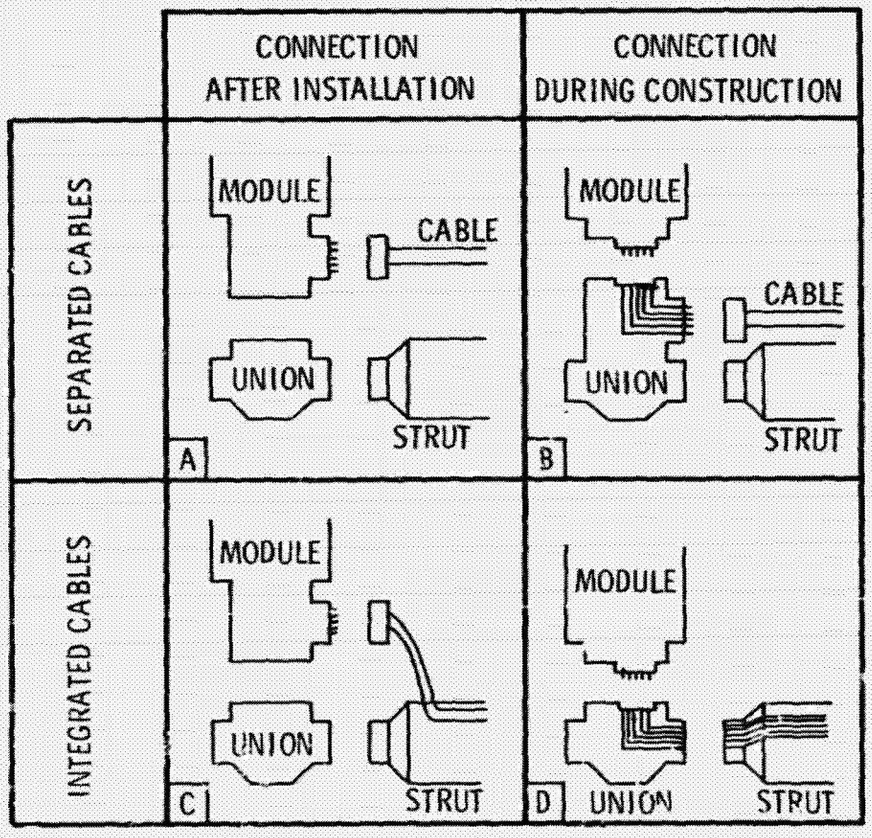
- FREQUENCY: 3 GHz
- 110 CHANNELS PER STATION (6 STATIONS)
- 4 DATA LINES PER STATION
- 4 CONTROL LINES PER STATION
- SEGMENT LENGTH: 32.2 METERS
- FIVE REFLECTORS, ONE SPARE
- TOTAL CABLE REQUIRED: 42.5 KM (141,666 FEET)
- DATA RATE = 85 MBPS PER DATA LINE
- BANDWIDTH = 100 MHz
- BER = 10^{-9}
- S/N = 13 DB
- F/O LINES PER BRANCH: 8

CABLE COMPARISON

CABLE	LOSS	WEIGHT
SHIELDED TWISTED PAIR	198 DB/KM	4,014 LB
SEMI-RIGID	92 DB/KM	11,687 LB
COAX	294	944 LB
FIBER OPTIC	20	41 LB

The various power and signal installation options are shown below. Option D is the desired configuration for the F/O distribution system.

POWER AND SIGNAL INSTALLATION OPTIONS



Based on requirements for the EMS system and an assessment of F/O technology, the following critical technologies were identified.

CRITICAL TECHNOLOGY IDENTIFIED

1. F/O CABLE TECHNOLOGY

- A SINGLE FIBER AND/OR MULTI-FIBER BUNDLES ARE REQUIRED THAT CAN WITHSTAND RADIATION EFFECTS (10^7 RADS) AND TEMPERATURE EXTREMES AS WELL AS PROVIDE SUFFICIENT CORE DIAMETER FOR CONNECTOR ALINEMENT.

(NO CABLE EXISTS AT THIS TIME THAT CAN MEET THESE REQUIREMENTS.)

2. CONNECTOR TECHNOLOGY

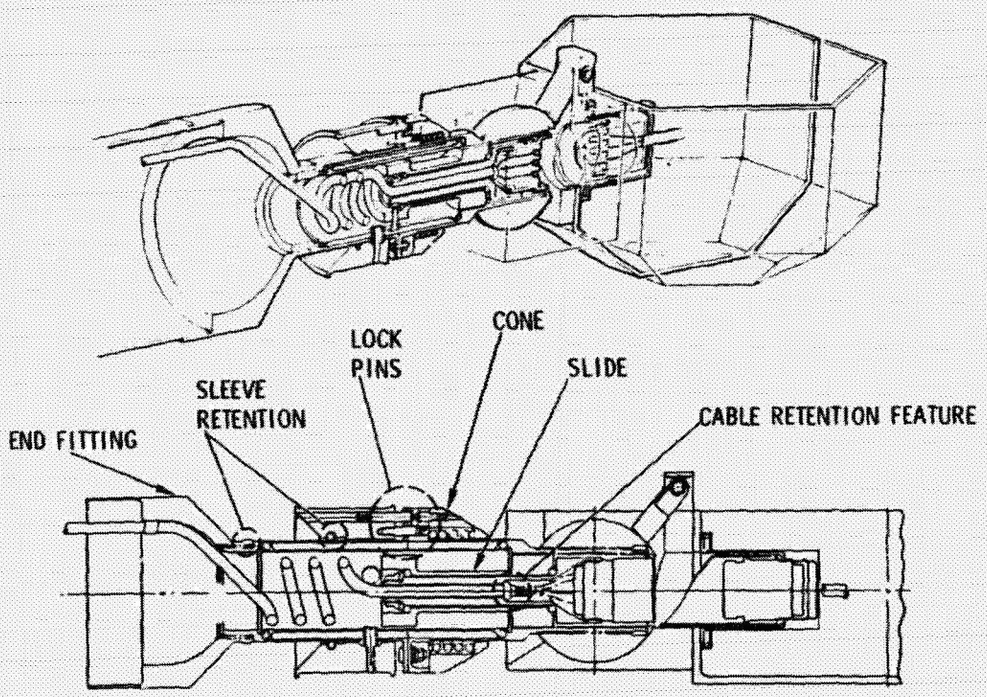
- A CONNECTOR IS REQUIRED THAT WOULD BE COMPATIBLE WITH CABLE DESCRIBED ABOVE.
- AN ASSEMBLY CONCEPT IS REQUIRED FOR MATING F/O CONNECTORS REMOTELY WITHIN STATE-OF-THE-ART LOSSES.

3. STRUCTURE INTEGRATION TECHNOLOGY

- METHODS MUST BE DEVELOPED FOR INTEGRATING F/O COMPONENTS INTO STRUCTURAL ELEMENTS.

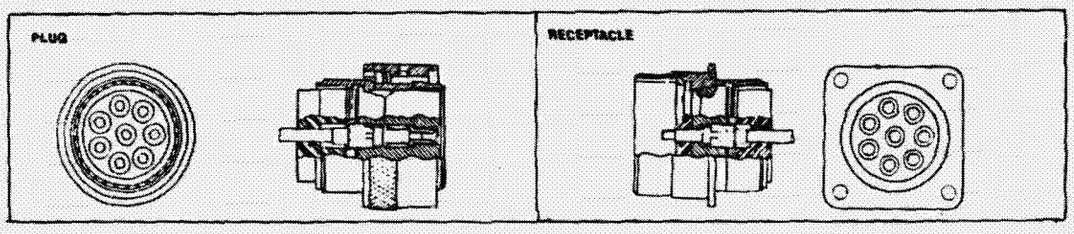
The F/O integrated connector assembly presently being developed by Rockwell International is shown below. This connector assembly shall be used to test two commercially available F/O connectors - (Amphenol and Hughes). These connectors will be assembled and tested so that the various system losses can be determined.

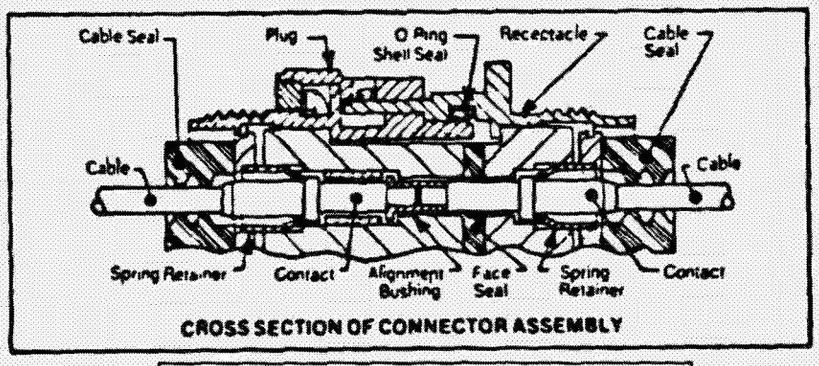
INTEGRATED CONNECTOR ASSEMBLY



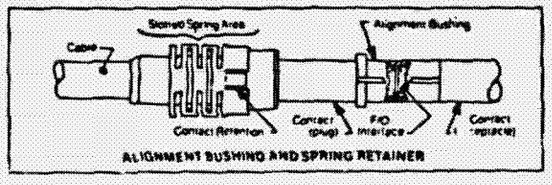
The Amphenol 8-Channel F/O connector is shown below.

AMPHENOL 8-CHANNEL FIBER OPTIC CONNECTOR





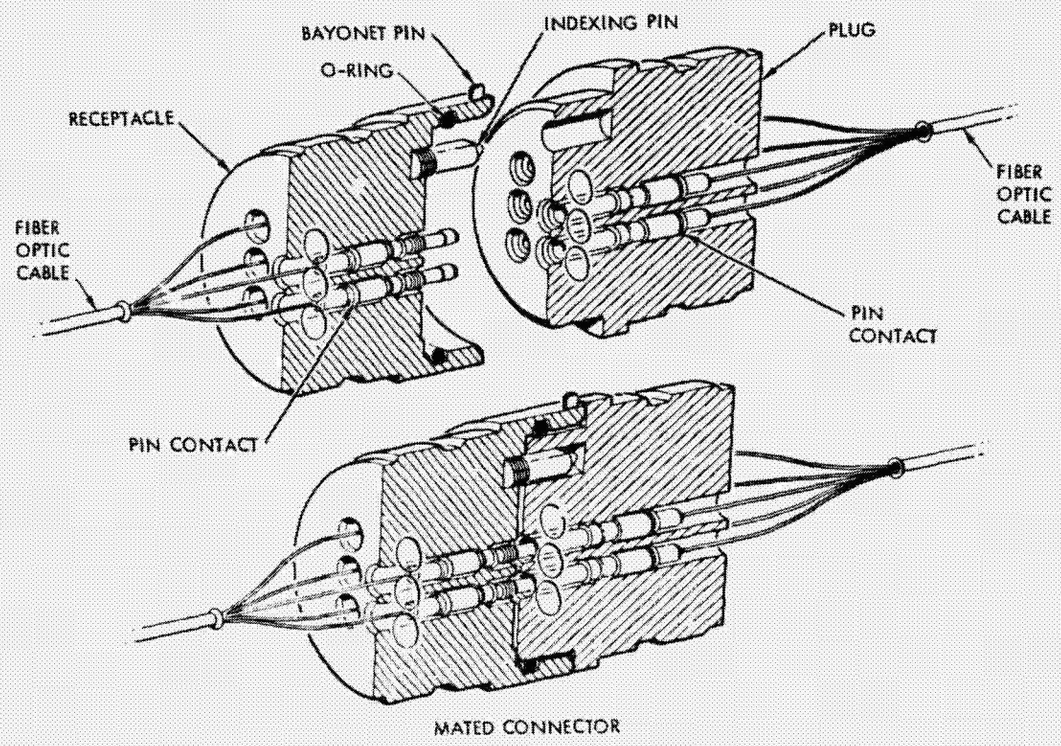
CROSS SECTION OF CONNECTOR ASSEMBLY



ALIGNMENT BUSHING AND SPRING RETAINER

The Hughes 8-Channel F/O connector is shown below.

HUGHES 8-CHANNEL FIBER OPTIC CONNECTOR



After the F/O Integrated Connector Assembly is fabricated,the following tests shall be conducted.

LARGE SPACE STRUCTURES

PROPOSED CONNECTION TESTS

- MEASURE FIBER OPTICS LIGHT LOSSES OF ASSEMBLY
- PERFORM REPEATED MATE/DEMATE OPERATIONS
- MEASURE LIGHT LOSSES DURING TEST CYCLE
- IDENTIFY LOSS PORTIONS
- MODIFY CONNECTION ASSEMBLY TO REDUCE LIGHT LOSSES
- REPEAT CYCLIC TESTS
- PREPARE TEST REPORT